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6. AUTHOR(S)
Stephen C. Riser

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
School of Oceanography
University of Washington
Box 357940
Seattle, WA 98195-7940

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This was a grant of funds during the period 1/1/91 - 9/30/96, for a total of $542,635, for the purpose of deploying 26 RAFOS floats and their associated acoustic tracking network in the western North Pacific for purposes of studying the deep circulation of the western Pacific, specifically the Deep Western Boundary Current (DWBC) off Japan. As a part of the grant, the floats were tracked after popping up at the end of their missions (two years after deployment), and the resulting data were analyzed.

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Final Report

Office of Naval Research Contract N00014–91–J-1522

Lagrangian Observations of the Deep Western Boundary Currents in the North Pacific During KERE

Stephen C. Riser, Associate Professor

School of Oceanography, University of Washington

Seattle, Washington 98195

1. Purpose of this Grant

This was a grant of funds during the period 1/1/91–9/30/96, for a total of $542,635, for the purpose of deploying 26 RAFOS floats and their associated acoustic tracking network in the western North Pacific for purposes of studying the deep circulation of the western Pacific, specifically the Deep Western Boundary Current (DWBC) off Japan. As a part of the grant, the floats were tracked after popping up at the end of their missions (2 years after deployment) and the resulting data were analyzed.

2. Goals of the Project

The goal of this project was to study the DWBC in the N. Pacific off Japan by examining the trajectories of neutrally-buoyant floats deployed in the DWBC. This study resulted from the observation that numerical model solutions of upper ocean flows in the western Pacific often appear to depend on the state of the deep ocean flow near the western boundary; this is presumably due to the fact that the upper ocean potential vorticity distribution is dependent on the potential vorticity in the deep ocean. Since little is known about the DWBC and the abyssal flow in the western N. Pacific, it was proposed to study these flows over a period of several years and to provide useful input to the construction of numerical models of the Pacific.

3. Results of the Project

In June of 1992, 26 RAFOS floats were deployed in the western N. Pacific as part of this project. Additionally, 3 acoustic sources were deployed. Of the 26 floats deployed, 9 were ballasted for a depth of 1000 m and 17 were ballasted for 3000 m. The floats were deployed during 2 voyages of the USNS *Desteiguer*, a research vessel operated by the Naval Oceanographic Office. During the first leg, from Seattle-Yokuska, Japan, the 3 acoustic source moorings and 11 floats were deployed. During the second leg, beginning and ending in Yokuska, the remaining 16 floats were deployed. The work during the second leg was closely coordinated with mooring deployment and CTD work carried out by scientists from the Naval Research Laboratory at Stennis, MS. Additionally, the float work was carried out in conjunction with float and sound source deployments by the PI sponsored by the National Science Foundation as part of the WOCE project. Including both the WOCE and KERE work, a total of 86 floats and 6 sound sources were deployed by the PI. Over both experiments, 92% of the floats and 5 out of 6 of the acoustic sources operated perfectly. For the KERE work, only 2 floats out of 26 and 1 out

of 3 sound sources failed to operate properly. A summary of KERE float and acoustic source mooring deployments are provided in accompanying tables.

The floats were designed to drift for a period of 2 years, after which they dropped a weight and ascended to the sea surface and transmitted data to an orbiting ARGOS satellite. The floats were designed to listen to 4 sound sources at any given time (3, or in some cases 2, sources are required for tracking). The sound sources were programmed to transmit twice per day. The float components were purchased from Bathysystems, Inc. of Exeter, Rhode Island, and the sources were purchased from Webb Research, Inc., of Falmouth, Massachusetts.

24 of the 26 floats surfaced 2 years after launch and transmitted their data. The floats showed a generally steady flow of 1–3 cm/sec at 3000 m in the vicinity of the Japan Trench east of the Japanese archipelago. Curiously, the flow was generally *northeast* on both the inshore and offshore sides of the trench, with a somewhat weaker flow to the *southwest* over the deepest portion of the trench. Some of the inshore floats travelled as far as the Kurile Islands, near Kamchatka, over the 2 year experiment. All of the measured flows were remarkably steady, with little eddy motion evident over the 2–year period. Furthermore, at 3000 m there appeared to be little interaction with the overlying Kuroshio, except for the floats furthest offshore. At 1000 m, there did appear to be some interaction with the Kuroshio, both on the inshore and offshore sides of the Japan Trench. When examined in the context of the KERE CTD section, plus other historical data from the region, it appears that the northward flows are associated with relatively new Pacific water that originated far to the south of the study region, with the southward flow in the center of the trench associated with very old deep water from the northern portions of the Pacific Basin. These results have been reported in a paper (Riser, 1997a) that has been submitted to *Journal of Physical Oceanography*.

The 1000 m floats, when examined together with the 1000 m floats deployed in WOCE, indicate that the western N. Pacific at mid-depth has significantly lower eddy kinetic energy than analogous regions of the western N. Atlantic, with the eastward flow along the Subarctic Front near 42°N being apparently as strong as the Kuroshio Extension near 35°N. It appears that both of these flows, as well as the eddy kinetic energy, is attenuated by the Emperor Seamounts near 167°E. East of the Emperor Seamounts the flows at 1000 m appear to be very weak. South of the Kuroshio Extension it appears that the eddy kinetic energy in zonal motions exceeds that in meridional motions by a factor of about 2, and that there are transient zonal flows present that extend for as much as 1000 km spatially with a meridional scale of only a few hundred kilometers. Paradoxically, while the Emperor Seamounts strongly constrain the Kuroshio Extension, the flow farther south appears to only weakly interact with the Izu-Ogassawara Ridge, even though this feature extends upward to a depth of 2000 m in the water column. This work has been reported in a paper (Riser, 1997b) that has been submitted to *Journal of Physical Oceanography*. The interaction of transient flows in the western Pacific and the underlying bathymetry is now under investigation in numerical models.

4. Refereed Publications Resulting from this Grant

1. Riser S.C. (1997a) The deep western boundary current in the N. Pacific off Japan. Submitted to *Journal of Physical Oceanography*.

2. Riser S.C. (1997b) Lagrangian observations of the large-scale flow at mid-depth in the western N. Pacific. Submitted to *Journal of Physical Oceanography*.

RAFOS Float Launch Data

USNS Desteiguer 6/92–7/92

Float Serial Number (Cruise Leg)	*Target Depth (m)*	*Start Time (UT)*	*Launch Time (UT)*	*Launch Position*	*Comments*
NP001 (1)	1000	0004 6/25/92	0931 6/25/92	39°59.8N 154°00.2E	OK; start 3 min. late
NP002 (1)	1000	1201 6/25/92	0500 6/26/92	39°59.7N 150°04.3E	OK
NP003 (1)	1000	1200 6/26/92	1751 6/26/92	37°47.2N 148°30.4E	OK;start 1 min. early
NP004 (2)	3000	0001 7/18/92	0817 7/18/92	33°52.4N 143°44.3E	OK
NP006 (1)	1000	0001 6/27/92	1348 6/27/92	34°32.0N 146°30.0E	OK
NP008 (2)	3000	1201 7/16/92	0929 7/17/92	34°39.1N 143°18.0E	OK
NP009 (1)	1000	1201 6/27/92	2258 6/27/92	33°28.9N 145°54.6E	OK
NP010 (1)	1000	0001 6/28/92	1708 6/28/92	34°23.5N 141°59.6E	OK
NP011 (2)	3000	1201 7/17/92	1709 7/17/92	34°16.1N 143°30.1E	OK; no lanyard hole
NP012 (2)	3000	0001 7/18/92	1616 7/18/92	33°22.6N 143°59.3E	OK
NP013 (2)	3000	1201 7/18/92	0822 7/19/92	32°56.6N 144°12.4E	OK
NP015 (2)	3000	0001 7/14/92	1723 7/14/92	35°30.0N 142°44.2E	OK
NP016 (2)	3000	0001 7/14/92	0949 7/15/92	35°44.1N 142°41.7E	OK; rough launch
NP017 (2)	3000	0001 7/16/92	0041 7/16/92	35°16.0N 142°52.2E	OK
NP018 (2)	3000	0001 7/13/92	1221 7/13/92	36°11.9N 142°18.4E	OK
NP019 (2)	3000	0001 7/13/92	1806 7/13/92	36°04.9N 142°21.0E	OK
NP021 (2)	3000	1201 7/12/92	1917 7/12/92	35°51.4N 142°35.3E	OK
NP022 (2)	3000	1201 7/10/92	1208 7/11/92	36°26.1N 142°11.2E	OK
NP023 (1)	3000	0001 6/28/92	0343 6/28/92	33°41.9N 144°50.1E	OK
NP024 (1)	3000	0001 6/28/92	1659 6/28/92	34°23.6N 141°59.7E	OK

Float Serial Number (Cruise Leg)	*Target Depth (m)*	*Start Time (UT)*	*Launch Time (UT)*	*Launch Position*	*Comments*
NP025 (1)	3000	0001 6/24/92	1219 6/24/92	39°59.6N 158°59.9E	OK
NP026 (1)	3000	1201 6/27/92	2248 6/27/92	33°29.0N 145°54.4E	OK
NP028 (2)	1000	1201 7/9/92	1655 7/9/92	36°40.1N 141°59.2E	OK
NP029 (2)	3000	1201 7/11/92	0505 7/12/92	36°15.7N 142°12.8E	OK; rough launch
NP030 (2)	1000	1201 7/9/92	1550 7/10/92	36°32.5N 142°05.2E	OK
NP031 (1)	1000	1201 6/22/92	0047 6/23/92	40°01.9N 166°10.3E	OK

Deployments total 9 1000 m floats and 17 3000 m floats, for a total of 26 float deployments on the Desteiguer cruises.

USNS *Desteiguer* Mooring Positions

Mooring	*Launch Date and Time (UT)*	*Nominal Bottom Depth (Corrected m)*	*Position*	*Transmission Time (UT)*
S1	6/23/92 0016	5610	40°02.7N 166°09.5E	0014 1214
S2	6/26/92 0452	5550	39°59.6N 150°04.1E	0100 1300
S3	6/27/92 2237	5755	33°29.1N 145°54.3E	0144 1344

Note: in each case the nominal depth of the sound source is 1000 m and the frequency is 251 hz.

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Stephen C. Riser, Principal Investigator
11 September 1997

Scientific Officer (03)
Dr. Steve Ramp, Code: 322PO
Office of Naval Research
800 N. Quincy Street
Arlington, VA 22217-5660

June A. Hawley (1-SF298 & DTIC Form 50)
Administrative Grants Officer
Office of Naval Research
Seattle Regional Office
1107 NE 45th Street, Suite 350
Seattle, WA 98105-4631

Director, Naval Research Laboratory (1)
Attn: Code 2627
Washington, DC 20375-5326

Defense Technical Information Center (2)
8725 John J. Kingman Road, Ste 0944
Ft Belvoir, VA 22060-6218

Sinh Simmons (1-SF298 only)
Senior Grant & Contract Coordinator
Grant & Contract Services
University of Washington
3935 University Way NE
Seattle, WA 98105-6613